CLAIMS

What is claimed is:

1. A method of damping mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:

   measuring an actual position value of a shaft using at least one sensor and/or measuring system;

   determining an actual speed of the shaft from the actual position value through differentiation;

   supplying the actual speed of the shaft as an input signal to each of a plurality of feedback elements, with each feedback element providing an output signal that is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and

   tuning each of the feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped.

2. The method of claim 1, wherein each of the feedback elements is a band-pass or high-pass element.

3. The method of claim 1, wherein each of the feedback elements is differential element with first-order delay or a differential element with second-order delay or higher order.

4. A method of damping the mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:
measuring an actual acceleration of a shaft by at least one sensor and/or measuring system;
supplying the actual acceleration of the shaft as an input signal to each of a plurality of feedback elements, with each feedback element providing an output signal that is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and
tuning each of the feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped.

5. The method of claim 4, wherein each of the feedback elements is a proportional element having a first-order delay or a proportional element having a second-order or higher-order delay.

6. The method of claim 4, wherein the supplying step includes the step of determining the actual speed of the shaft from the actual acceleration through integration, wherein each of the feedback elements is a differential element having a first-order delay or a differential element having a second-order or higher order delay.

7. A method of damping the mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:

measuring an actual position value of an shaft using at least one sensor and/or measuring system;

determining an actual acceleration of the shaft from the actual position value through second-order differentiation;

supplying the actual acceleration of the shaft as an input signal to each of a plurality of feedback elements, with each feedback element providing an output signal that is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and

tuning each of the feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped.

8. The method of claim 7, wherein each of the feedback elements is a proportional element with first-order delay or a proportional element with second-order delay or higher order.

9. The method of claim 7, wherein the supplying step includes the step of determining from the actual acceleration the actual speed of the shaft through integration, wherein each of the feedback elements is a differential element with first-order delay or a differential element with second-order delay or higher order.

10. A method of damping mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:

measuring an actual speed of a shaft by at least one sensor and/or measuring system;

supplying the actual speed of the shaft as an input signal to each of a plurality of feedback elements, with each feedback element providing an output signal which is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and

tuning each of the feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped.

11. A method of damping mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:

measuring an actual acceleration of a shaft by a first type of sensor and/or measuring system;

measuring an actual speed of the shaft by a second type of sensor and/or measuring system;

supplying the actual acceleration of the shaft as an input signal to a first set of feedback elements to provide an output signal that is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor;

supplying the actual speed of the shaft as an input signal to a second set of feedback elements to provide an output signal that is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and

tuning each of the first and second sets of feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped,

wherein each of the first and second sets of feedback elements includes at least one feedback element.

12. A method of damping mechanical oscillations of at least one shaft of a machine tool, manufacturing machine or robot, said method comprising the steps of:

determining an actual state variable of the shaft;

supplying the actual state variable of the shaft as an input signal to each of a plurality of feedback elements, with each feedback element providing an output signal which is negatively coupled and applied to a desired speed signal of a motor speed controller of a driving motor; and

tuning each of the feedback elements to a specific oscillation frequency range of the shaft oscillations that is to be damped.

13. The method of claim 12, wherein the determining step includes the steps of measuring an actual position value of the shaft by a measuring means, and ascertaining the actual state variable as an actual speed of the shaft obtained from the actual position value through differentiation.

14. The method of claim 12, wherein the determining step includes the steps of measuring an actual acceleration of the shaft, and ascertaining the actual state variable as an actual speed of the shaft obtained from the measured actual acceleration through integration.

15. The method of claim 12, wherein the determining step includes the step of ascertaining the actual state variable as a measured actual acceleration of the shaft.

16. The method of claim 12, wherein the determining step includes the steps of measuring an actual position value of the shaft, and ascertaining the actual state variable as an actual acceleration of the shaft obtained from the measured actual position value through second-order differentiation.

17. The method of claim 12, wherein the determining step includes the step of ascertaining the actual state variable as a measured actual speed of the shaft.

18. Apparatus for damping mechanical oscillations of a shaft of a machine tool, manufacturing machine or robot having a driving motor, comprising:

plural feedback elements, each feedback element being adapted to generate an output signal that is negatively coupled and added to a desired speed signal of a motor speed controller of the driving motor;

measuring means for measuring a shaft variable;

means for determining an actual shaft variable from the measured shaft variable by calculation;

means for supplying the calculated shaft variable as an input signal to each feedback element; and

means for tuning each feedback element to a respective oscillation frequency range of the shaft's oscillations that is to be damped.

19. The apparatus of claim 18, wherein a tuned band-pass filter is used as a feedback element for one of the oscillation frequency ranges of the shaft's oscillations that is to be damped.

20. The apparatus of claim 18, wherein a tuned high-pass filter is used as a feedback element for one of the oscillation frequency ranges of the shaft's oscillations that is to be damped.

21. The apparatus of claim 18, wherein a tuned differential element having at least a first-order delay is used as a feedback element for one of the oscillation frequency ranges of the shaft's oscillations that is to be damped.

22. The apparatus of claim 18, wherein a tuned proportional element having at least a first-order delay is used as a feedback element for one of the oscillation frequency ranges of the shaft's oscillations that is to be damped.